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Study of Structural Irregularities in different Seismic Zones using Response Spectrum Analysis

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Abstract: The Indian Standard code IS-1893: 2002 (Part-I) defines various types of structural irregularities. The code suggests a special approach of study for irregular structures. The earthquake effect leads to the damage the property and many people loss their life. So, we've to understand the structural performance under seismic load before construction. In this study varying plan irregularities which are often inevitable thanks to building requirements and architectural imperatives, and having a serious impact on building costs are investigated.

The objective of the project is to carry out Response spectrum analysis of two RCC buildings is to be done in four different seismic zones of India (i.e., Zone-2, Zone-3, Zone-4, Zone-5). ETABS model of G+10 RCC with Varying Geometry plan is considered in this analysis. The analysis is done using Extended Three-Dimensional Analysis of Building System software. Various response parameters like lateral force, story drift, Displacement are often determined. The evaluation of response of structures subjected to lateral loading with the help of frequency and the magnitude of stress resultant, is also included in the scope of this paper.

Keywords: Plan irregularity, Vertical geometric irregularities Response spectrum method, ETABS, Structural Irregularities, Lateral Loading, Non-Linear Analysis, Storey Drift, Storey Displacement.

I. INTRODUCTION

The structural irregularities that affect the behavior of the structure under static and dynamic loads or its resistance to these loads vary widely with the design. The failure of any structure starts at points of weakness, during an earthquake. This weakness arises thanks to discontinuity in mass, stiffness and geometry of structure. The structures having these discontinuities are called as Irregular structures. Irregular structures contribute an outsized portion of urban infrastructure. Plan irregularities are one of the major reasons of failures of structures during earthquakes. The behavior of a building during an earthquake depends on several factors like stiffness, lateral strength, and ductility, simple and regular configurations. The buildings with uniformly distributed mass, stiffness and regular geometry, suffer much less damage compared to irregular configurations. But nowadays as trend is changing, the preference of new generation engineers is towards an irregular configuration for better aesthetic perspective. The role and use of Non-linear Analysis in Seismic Design while buildings are usually designed for seismic resistance using elastic analysis, most will experience significant inelastic deformations under large earthquakes. Modern performance- based design methods require ways to work out the realistic behavior of structures under such conditions. As there are advancements in computing technologies and available data, nonlinear analysis provides the means for calculating structural response beyond the elastic range, including stiffness and strength deterioration associated with inelastic material behavior and large displacements. As such, nonlinear analysis can play a crucial role within the design of latest and existing buildings. Nonlinear analysis involves significantly more effort to perform and should be approached with specific objectives in mind.

In the current study, two different shapes of building are studied to stipulate the effect of plan irregularity. The following parameters are considered and studied: Storey Displacement, Storey Drift, and Time Period.

II. OBJECTIVES

A. The main objective of this project is to study seismic response of the multi-storey buildings (G+10) with varying plan irregularities.
B. To Study & Analyse the behavior of irregular building subjected to lateral loading with the help of frequency, therefore the magnitude of stress resultant.
C. To find the structural behavior of multi storey buildings like storey drift, storey displacement, and time period.

III. METHODOLOGY

The study is carried out for the behavior of three R.C buildings with Rectangular and L-shape plan. Post analysis of structures, storey drift, storey displacement and time period are computed for all the analyzed cases. Modelling of RCC frames contains a gathering of beams, columns, slabs and foundation interconnected to each other as a unit. Load transferal mechanism in these structures is from slabs to beams, from beams to columns, then columns to foundation and permits the load to soil. In this structural analysis study, we have assumed two cases of different shapes for same structures i.e.

1) Rectangular plan
2) L-shape plan

A. Model Description

1) Rectangular Plan

Frame size: 20x26m Building size
Plan Area: 520 m^2
X-direction grid spacing: 5.3 m
Y-direction grid spacing: 6.2 m
Number of stories: G+10
Height of each storey: 3.3 m
Plinth height: 1.5 m
Total height of building: 34.7 m
Depth of slab: 150 mm

2) L-shape Plan

Frame size: 17.9x23 m Building size
Plan Area: 411.7 m^2
X-direction grid spacing: 4.8 m
Y-direction grid spacing: 6.9 m
Number of stories: G+10
Height of each storey: 3.3 m
Plinth height: 1.5 m
Total height of building: 32.8 m
Depth of slab: 150 mm

B. Material Properties

Grade of concrete: M35
Grade of steel: Fe500
Density of concrete: 25 KN/m^2
Density of steel: 78.5 KN/m^3

C. Member Properties

1) Rectangular Plan

Beam: 400x600 mm, 900x500 mm
Column: 300x700 mm, 450x750 mm
Thickness of brick wall: Outer 230mm
Inner 150mm
Thickness of slab: 150mm
Height of parapet wall: 0.9m

2) L-shape Plan

Beam: 400x650 mm, 900x500 mm
Column: 300x700 mm, 450x750 mm

Thickness of brick wall: Outer 230mm
Inner 150mm
Thickness of slab: 150mm
Height of parapet wall: 0.9m

D. General Loadings

Live load [IS 875, part 2]: 3kN/m^2
Floor finish: 1.5kN/m^2
Wall load: 11.73kN/m^2
Parapet wall load: 4.14kN/m^2

E. Modelling

Models are prepared for the plan area 520 m^2 of G+10 storey building different plan configuration of rectangular and L-shape using ETABS software.

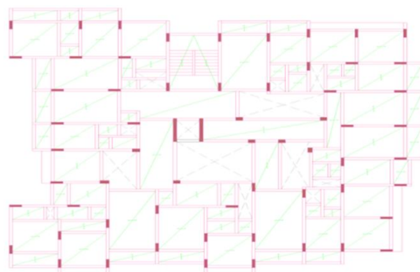
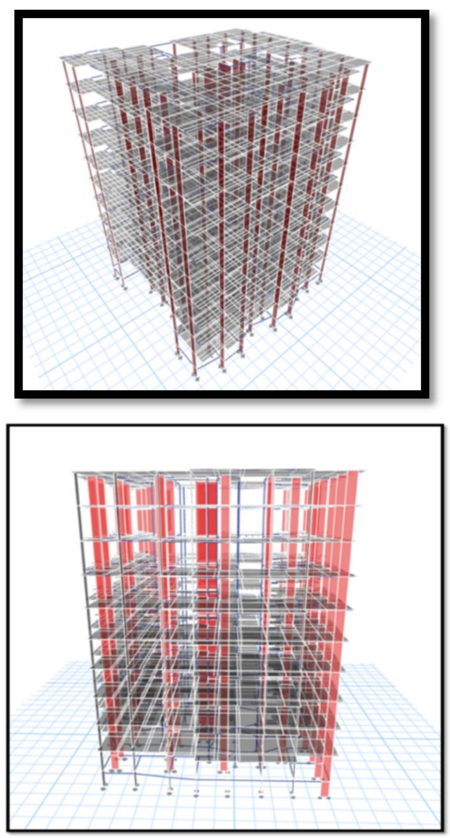


Fig.1. Plan of rectangular model



Model 1 – Rectangular Shaped model

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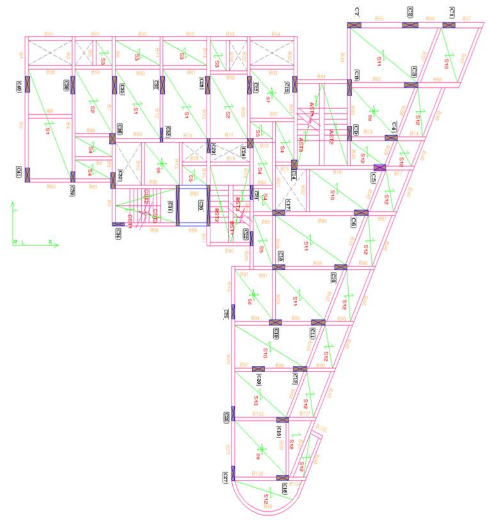
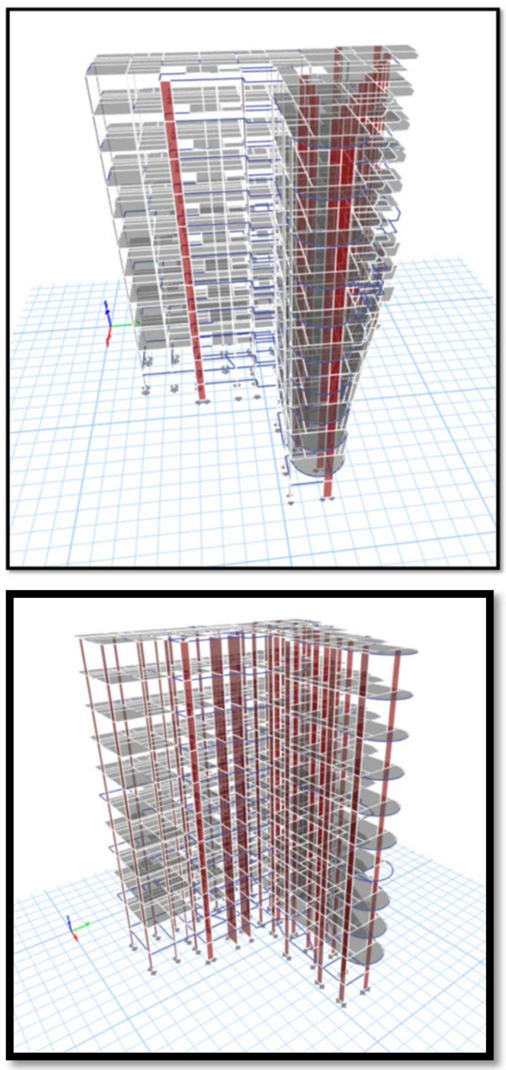


Fig.2. Plan of L-shape model



Model 2 - L-shape model

IV. ANALYSIS AND RESULTS

The seismic response of multi storied building of plan configuration Rectangular and L-shape is determined to obtain the response quantity of building such as storey drift, displacement by carrying out Response spectrum method using ETABS. The results are extracted for various parameters such as Storey displacement, Storey drift.

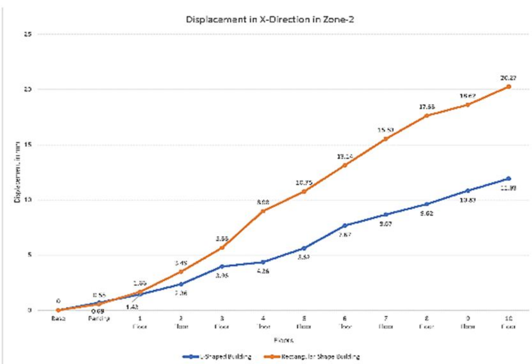
A. Analysis & Results

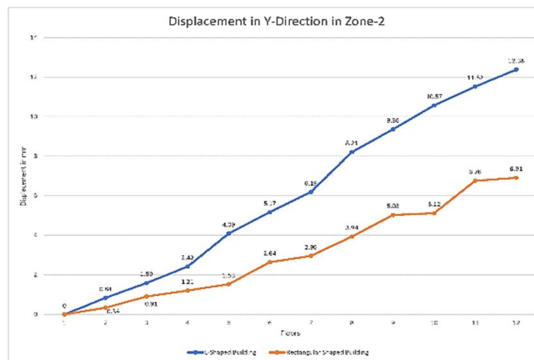
We have compared the two buildings in Graphical Representation. For which, we made the graphs for Maximum Storey Displacement & Maximum Storey Drift. We have made the graphs for different seismic zones i.e., zone 2, zone 3, zone 4 and zone 5. Blue line indicates readings for L shaped Building and Red Line indicates the readings for rectangular Shaped Building.

The Graphical Comparison of the buildings with plan irregularities is shown below.

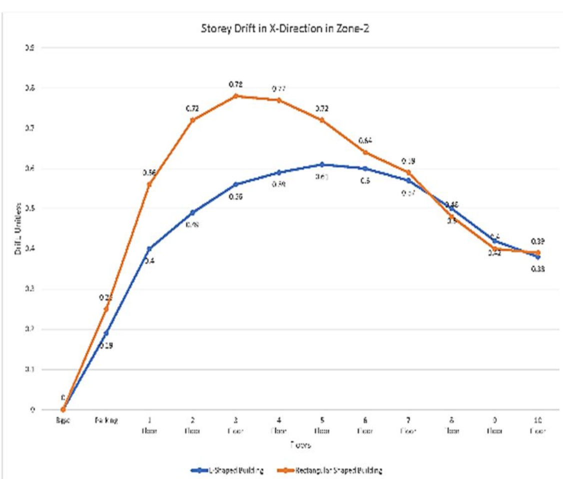
1) Zone 2

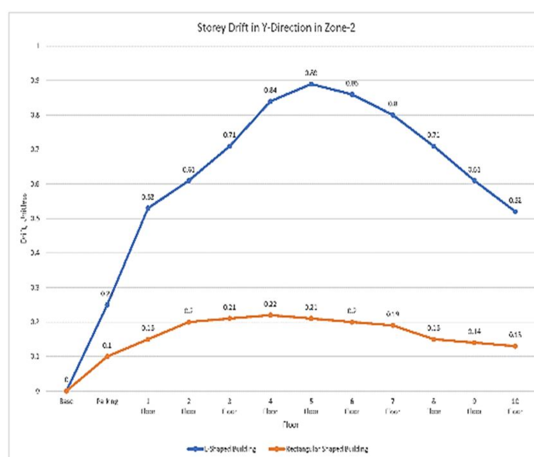
- *Storey Displacement Graph in X & Y direction*





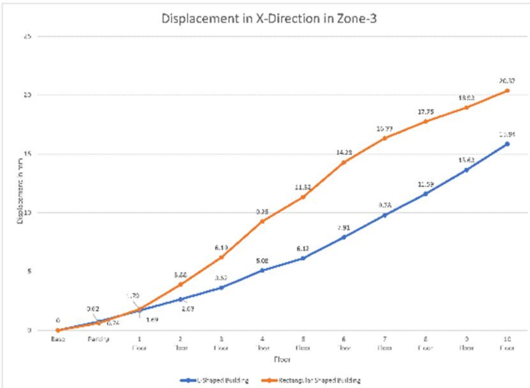
- *Storey Drift Graph in X & Y direction*

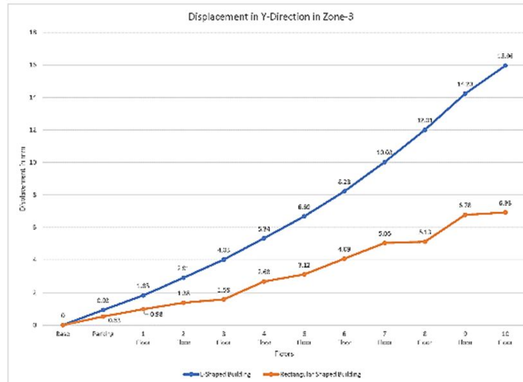




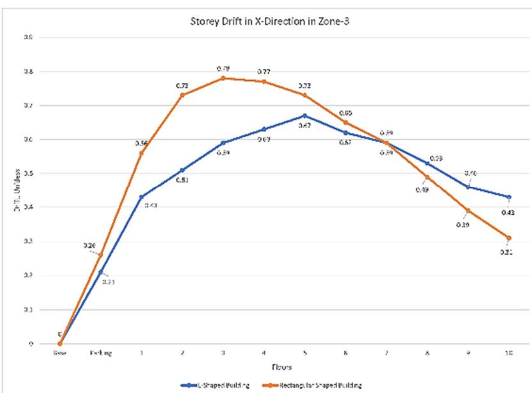
2) *Zone 3*

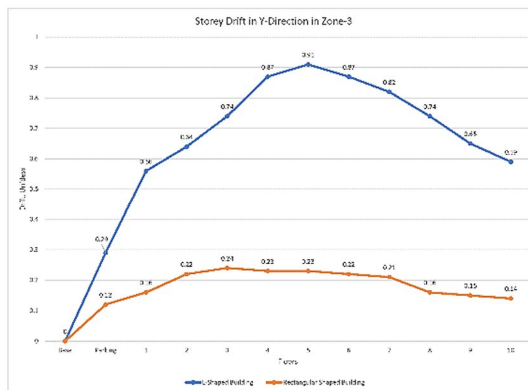
- *Storey Displacement in X & Y Direction*





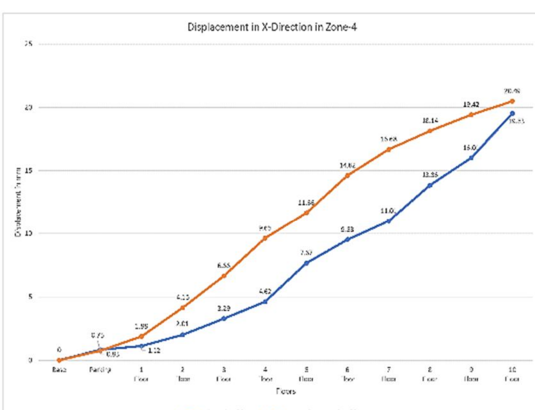
- *Storey Drift Graph in X & Y Direction*

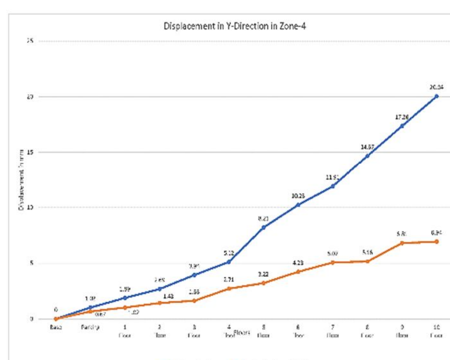




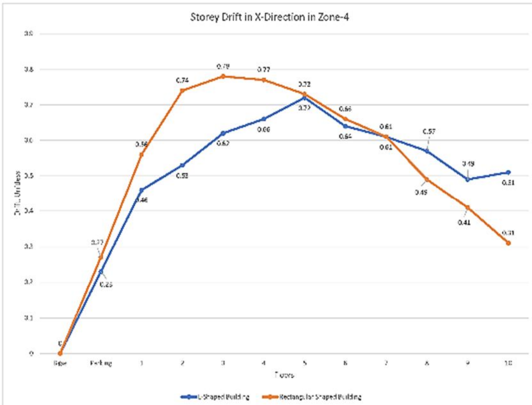
3) *Zone 4*

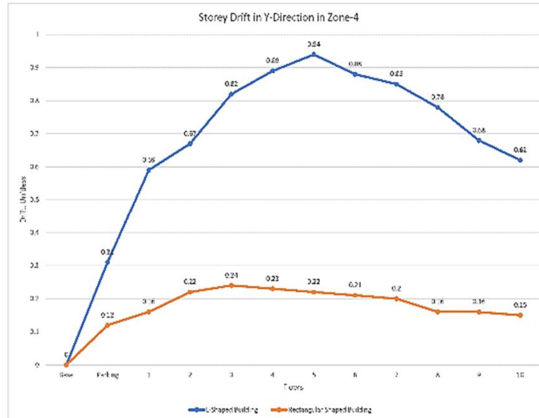
- *Storey Displacement Graph in X & Y Direction*





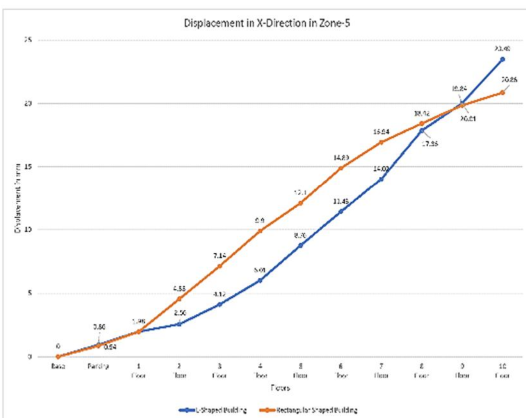
- *Storey Drift Graph in X & Y Direction*

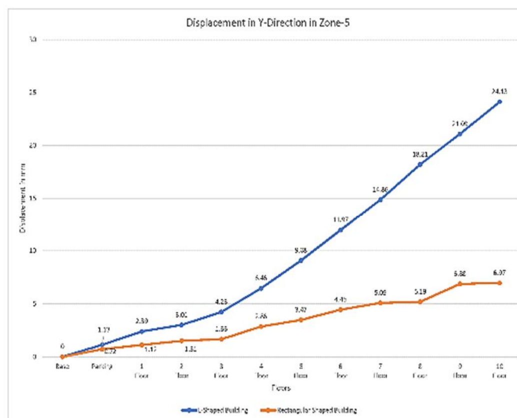




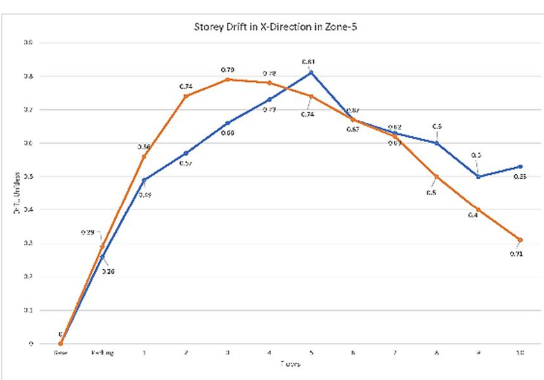
4) *Zone 5*

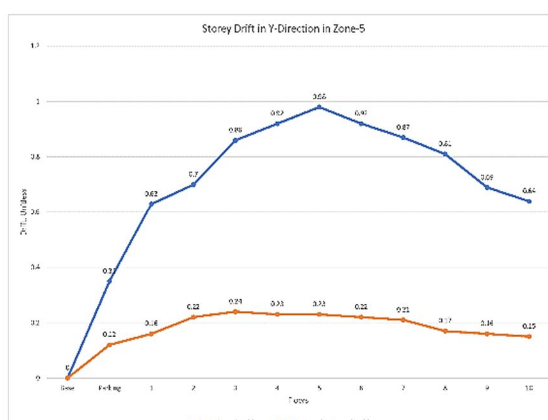
- *Storey Displacement Graph in X & Y Direction*





- *Storey Drift Graph in X & Y Direction*





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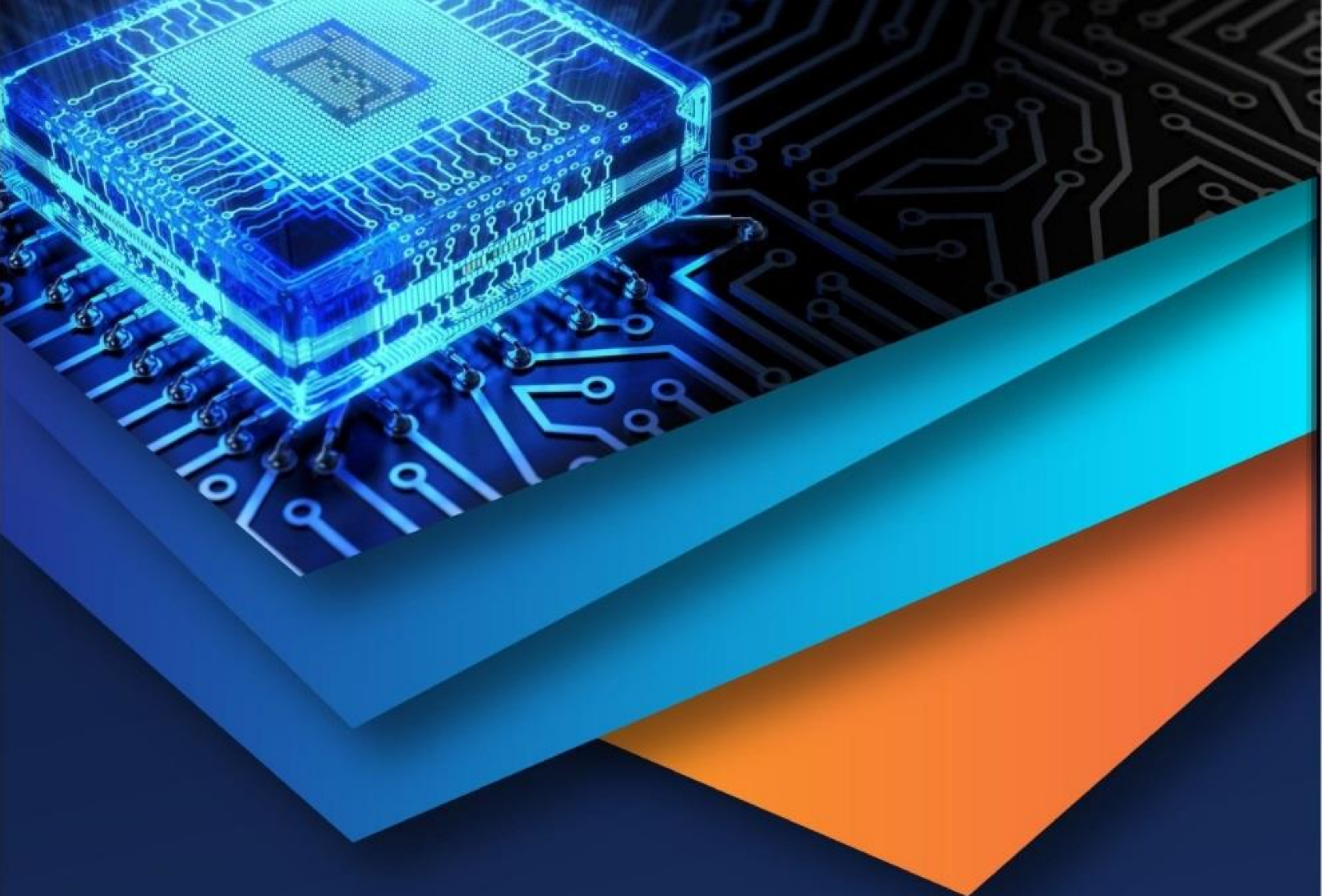
V. CONCLUSION

A. The plan configuration of structures proves its influence on the seismic response of structure in terms of, displacement, storey drift.
B. Lateral displacement is observed in L shape model 16.3% increase than rectangular model. It describes that building with severe irregularities shows maximum displacement and storey drift.
C. According to results of Response spectrum and Modal Mass Participation method of analysis, the storey drift found to be maximum in L shape in the case of plan irregularities. It is observed that the storey drift for all stories is found to be within the permissible limits.
D. With Increase in Height of the building, it was observed that Story Displacement Increases, Story Shear Decreases.
E. The Frequency & Vibrations is Maximum in the top Storeys of the Building.
F. During Modal Mass Participation Ratio Analysis, it is observed that the modal time period decreased by 0.96% in irregular building as compare to regular building.

REFERENCES

[1] Abhilash. R, "Effect of lateral load patterns in Pushover analysis", 10th National Conference on Technological Trends (NCTT09) 6-7, India, 2009.
[2] Arvind reddy and R. J. Fernandes (2015) " Seismic analysis of RC regular and irregular frame structures" International Research Journal of Engineering and Technology (IRJET) ISSN: 2395-0056, Volume2, Issue5.
[3] Amit Singh, Himank Ghulyani, "Seismic Analysis of Multi-Storey RCC Building and Steel Building Using Etabs" International Journal of Advance Engineering and Research Development Volume 4, Issue 7, July -2017.
[4] D'Ambrisi A, De Stefano M, Tanganelli M. Use of pushover analysis for predicting seismic response of irregular buildings: a case study, Journal of Earthquake Engineering, No. 8, 13(2009) 1089-1100.
[5] De Stefano M, Pintucchi B. A review of research on seismic behavior of irregular building structures since 2002, Bulletin of Earthquake Engineering, No. 2, 6(2008) 285-308.
[6] Hirde S. & Aher R., (2016). Seismic Evaluation of Irregular Structures. International Journal of Engineering Research, 5(3): 750-755.
[7] James A T.& Khatri A P., (2015). Seismic Assessment of Vertical Irregular Buildings. Journal of Basic and Applied Engineering Research, 2(9), 788-795.
[8] Naveen E.S, Abraham N.M & Kumari S D. A. (2018). Analysis of Irregular Structures under Earthquake Loads. Elsevier Journal, Procedia Structural Integrity 14: 806–819.
[9] Nonaka. N, Mrs. Gargi DandaDe, "Comparative Studies on Seismic Analysis of Regular and Vertical Irregular Multi-Storied Building", International Journal for Research in Applied Science & Engineering Technology (IJRASET)Volume 3 Issue VII, July 2015.
[10] Patil S. S, Ajim Mujawar G. & Pritam Mali Murugesh Katti, R. (2017). A Study of Torsional Effect on Multistoried Building with Plan Irregularity. International Journal of Advanced Research, 5(1), 1625-1632.
[11] Prof. Swapnil, B. Cholekar, Basavalingappa "Comparative analysis of multistoried RCC and composite building due to mass irregularity" IRJET, Volume 2, Issue 4, July 2015.
[12] Rakshith G.M, Panender naik G, Swarna D et al "Analysis of G+20 RC tall building in different zones using E-Tabs" IJIRSET, Volume 8, Issue 5, May-2019.
[13] Ravikumar C. M., Babu Narayan K. S., Sujith B. V. & Venkat Reddy D., (2012). Effect of Irregular Configurations on Seismic Vulnerability of RC Buildings. Architecture Research.
[14] Shelke R N. & Ansari U.S., (2017). Seismic Analysis of Vertically Irregular RC Building Frames. International Journal of Civil Engineering and Technology (IJCIET).
[15] Soni DP, Mistry BB. Qualitative review of seismic response of vertically irregular building frames, ISET Journal of Earthquake Technology, No. 4, 43(2006) 121-32.



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